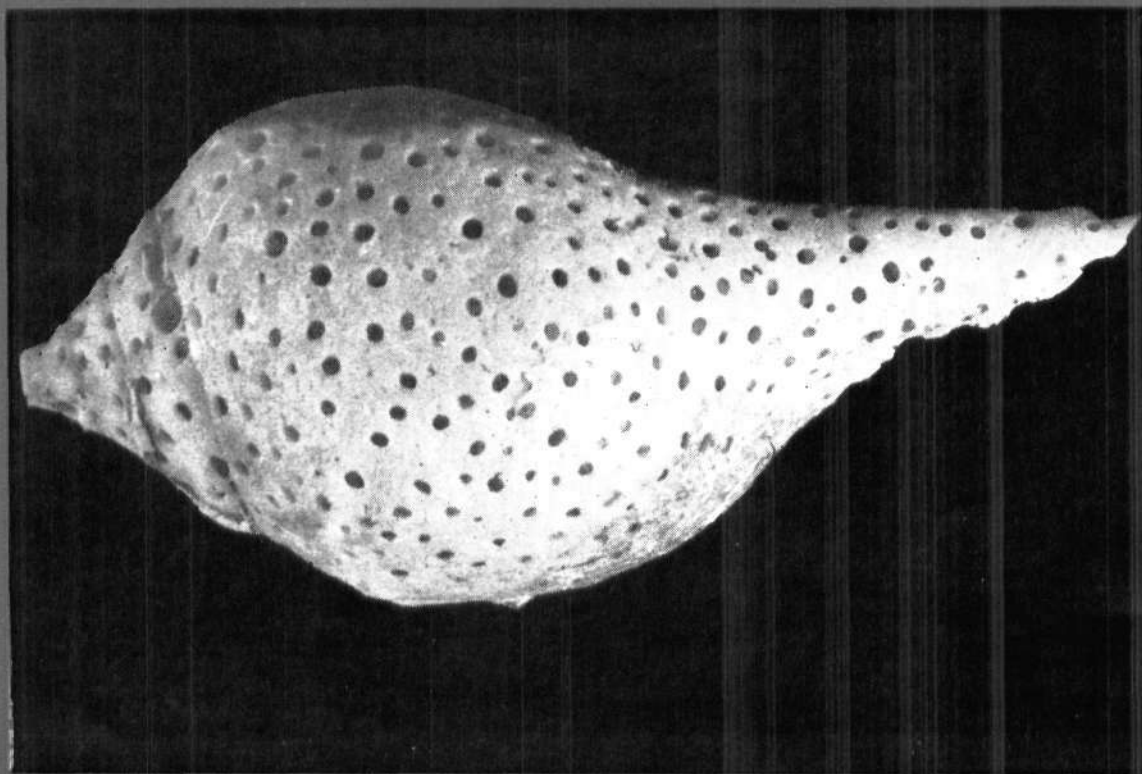




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Cover Photo: Chank bored by sponge

CALCIBIOCAVITOLOGICAL INVESTIGATIONS

P.A. Thomas, K.K. Appukuttan, K. Ramadoss and S.G. Vincent

1. Introduction

Several species of marine organisms are known to excavate cavities inside hard calcareous objects like shell, coral, lime stone etc. either by chemical or mechanical means or by a combination of both. Representatives of about 12 major taxa of marine algae and invertebrate animals are known to engage themselves in such destructive activities in the marine environment. A lot of information has already been amassed in the past century on the systematics, distribution, ecology and physiology of these organisms from different parts of the world. The biological, chemical and geological changes that these organisms would bring about in the marine environment are, by no way, insignificant as they cause bioerosion, influence calcium balance in the sea, and control the structure of calcium carbonate producing communities.

Animals which excavate hard calcareous objects by mechanical means often remove the hard particles from the latter in chips or in any other form that is characteristic to the species, and such particles often form a sizable fraction of the sediment adjoining the respective environment. Boring sponges, which chip out minute calcium carbonate particles of more or less uniform size and shape by a combination of enzymatic and physical action, expel them through the oscula. Such particles often contribute about 2-30% of the total sediment load in the reef environment. These sponges, while removing such chips from the substratum, only 2-3% goes in dissolved form. It is estimated by earlier workers that in reef environment with high sponge concentration, the erosion rate may go up to 3 kg m⁻² year⁻¹ or 1 mm per year. On the other hand, animals which resort to burrowing by chemical means often dissolve calcium carbonate matter which may mix with sea water and this will, to a certain extent, alter the calcium balance in the environment.

Calcium carbonate penetration by marine organisms (calcibiocavitation) is a major problem in the marine environment. In areas where corals and economically important molluscan beds occur, precise information on the number of such deleterious species and the magnitude of damage caused by them to the calcium secreting animals are prerequisites for an efficient management of both natural and tended stocks. With this end in view, a detailed study on these

aspects has been undertaken during the years 1980-'82, and the salient findings which emerged are presented here.

Gregarious molluscs such as the sacred chank *Xancus pyrum* (Lam.), mussels (both green and brown), rock oysters (*Crassostrea* spp.), pearl oysters, *Thais rudolphi* (Lam.) and corals which inhabit the southwest coast of Kerala and the Gulf of Mannar have been investigated in detail for the various animals which destroy them by boring into their hard parts. It is found from the investigations that the major groups of animals which destroy them are 1) sponges, 2) molluscs, 3) polychaetes, and 4) sipunculids. When the sponge bores into a live molluscan shell the latter may exhibit both physical and physiological strain and this may result in a variety of pathological manifestations. A detailed account on 12 well recognised diseases which occur in molluscs due to the infection of sponges has been published by Thomas (1980, Symp. Coastal Aquaculture, Mar. biol. ass. India)

The various groups of boring organisms are dealt with below:

2. Sponges

2.1 As pests of Chanks (Figs. 4B, 5A, B, C)

2.1.1. Incidence of boring sponges

Every year a sizable fraction of the chanks exploited at each centre along the Indian coast is being discarded as 'wormed'. Detailed study made by Thomas (1979, Indian J. Fish. 26, 1 & 2) revealed that all such 'wormed' shells are bored by sponges and the percentage of worm attack on them is practically nil.

Examination of the data published elsewhere (Bull. C.M.F.R.I. No.25) shows that the incidence (infection per 100 shells collected at random) during the years 1961-1967 at Tuticorin fluctuated between 1.5 and 20.9 and this percentage, when compared with that seen in the beds off Sivaganga, Ramanathapuram, Tanjavor and Kanyakumari, is very low. The rates of incidence noted at Tuticorin beds during the seasons 1980-'81 and 1981-'82 were 10.9 and 8 percent respectively (Fig.1A)

The chank beds off Thiruchendur are only occasionally fished as compared to those off Tuticorin; and

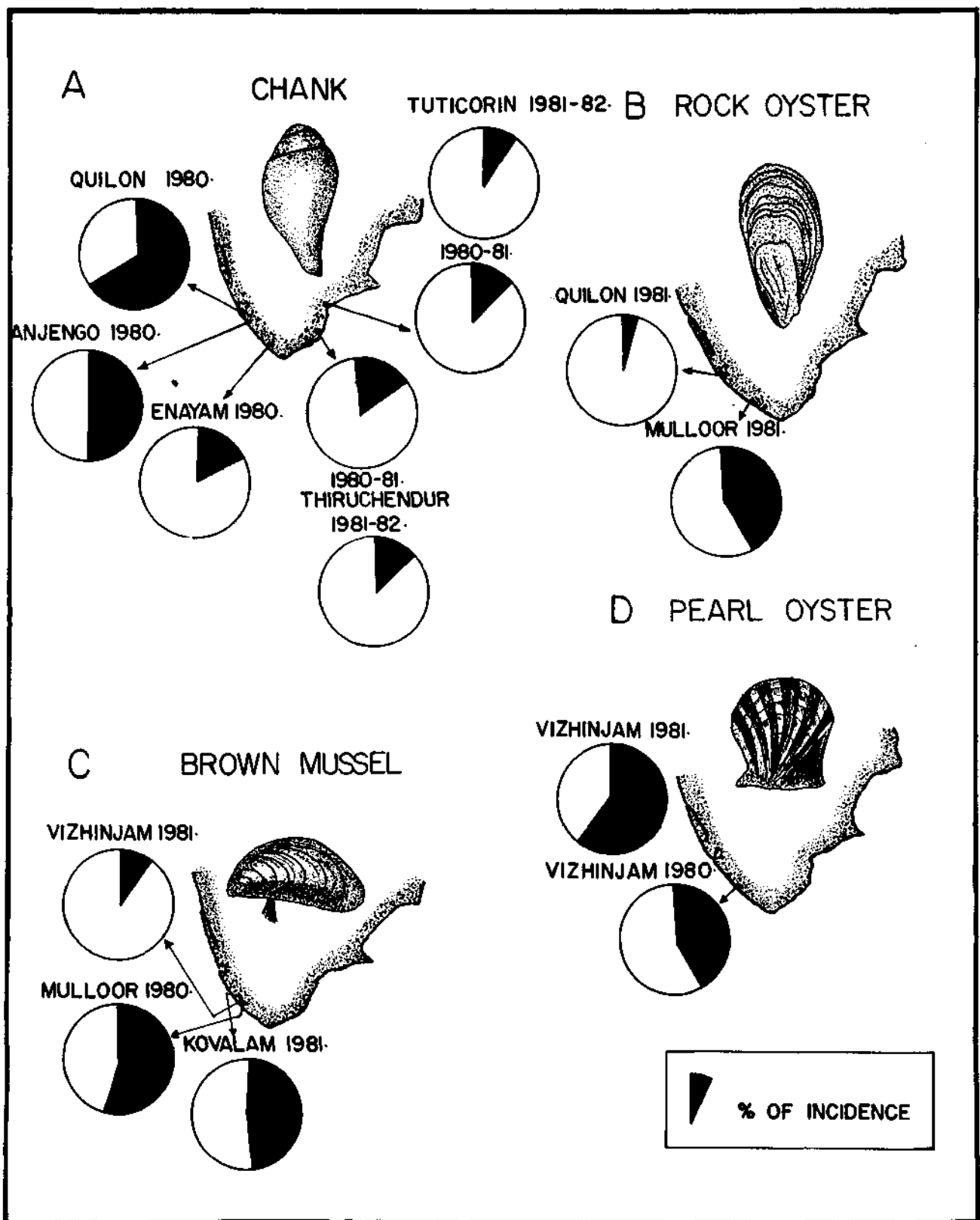


Fig. 1. A-D Percentage of incidence of boring sponges in chanks, mussels and oysters at different places.

recently when the fishing resumed in 1980-'81 season, the incidence was found to be quite high (17%). But during the ensuing season, i.e. 1981-'82, the incidence came down to 12.2% (Fig.1A).

The rate of incidence varied considerably from 'paar' to 'paar' as also from year to year. During 1980-'81 season, at Tuticorin, the maximum incidence of boring sponges was noted at Meleonbothu paar (30.57%) and the minimum at Siluvai paar (6.9%). A more or less similar pattern was noted at Thiruchendur beds also with the maximum at Thiruchendur Karai paar (34.2%) and the minimum at Karuwal paar (18.77%).

Investigations on the chank beds off the southwest coast of Kerala revealed a low incidence (10.15%) at the southern centre (Enayam), whereas the same increased abruptly towards the northern centres like Anjengo and Quilon. During 1980, the incidence recorded at Quilon was about 60% and at Anjengo, 50% (Fig.1A).

2.1.2. Species of boring sponges

Species of boring sponges which infect the chank shells, in the order of abundance, were 1) *Cliona celata* Grant, 2) *C.vastifica*, Hancock, 3) *C.carpenteri* Hancock and 4) *C.lobata* Hancock. An earlier study made by Thomas (1979, op. cit) revealed only the first three species in the chank beds of the Gulf of Mannar, and hence *C.lobata* may be considered to be the most recent intruder into the chank beds of the Gulf of Mannar.

2.1.3. Abundance and population structure

C.celata formed the most dominant pest of chanks in the Gulf of Mannar up to 1981. But subsequently, i.e. in 1981-'82 season, this composition changed and *C.vastifica*, which had only a secondary role in the chank beds till 1981, dominated. Hence 1981-'82 season may be considered to be a transitional period when the dominance shifted from an established species (*C.celata*) to a less important one (*C.vastifica*) (Fig.2A)

Another important finding emerged during the present study is the infiltration of *C.lobata*, a dreadful pest of rock oysters of the Atlantic, into the Indian chank beds. Until 1980-'81 season there were only three species of boring sponges in the chank beds of the Gulf of Mannar, and the presence of *C.lobata*, the 4th species, may pose a serious threat to the economically important molluscs of the Gulf of Mannar as a whole. At present this species is confined to the chank beds of Thiruchendur alone, but it is likely to spread throughout the Gulf of Mannar (for further details on

the infiltration of this species into various other species of molluscs, refer the section 2.2.2)

In the chank beds extending along the southwest coast of Kerala the dominance of *C.vastifica* is noted only in the southern centre (Enayam) and here it practically co-exists with *C.carpenteri*. But towards the northern part of this zone its position has been taken up by *C.celata*. In the chank beds off Vizhinjam, *C.celata* dominated (67%) among boring sponges during 1981, followed by *C.celeta* (33%). But in the northern centres like Anjengo and Quilon only *C.celeta* was noted. But this monospecific dominance of *C.celata* in the Quilon beds did not last long, and chanks collected during the next season, i.e. 1980-'81, included *C.vastifica* in stray numbers (13.4% of the population). During the subsequent season, i.e. 1981-'82, though *C.celata* still constituted the major component among the boring sponges, *C.vastifica* disappeared totally from the bed, and its place has been taken up by *C.lobata*, a species unknown in the chank beds off the southwest coast of India till 1980-'81, constituting about 20% of the boring sponge population (Fig.2A).

The present infiltration of *C.lobata* into the chank beds of the southwest coast of Kerala is the first major attempt in colonising the chank beds of this area. The infiltration period of this species into the Quilon chank beds exactly coincides with the infiltration of *C.lobata* into the chank beds of Thiruchendur during 1981-'82 season.

C.carpenteri, which is found wide spread in the chank beds off Tuticorin and Thiruchendur, is met with only in the southern centre (Enayam) and is totally absent from the northern centres.

2.2. As pests of pearl oysters (Figs. 4C, D, 5D)

2.2.1. Incidence of boring sponges

It was not possible to examine the pearl oysters from the natural beds of Tuticorin during the present investigation. The first report on sponges as the major enemy of the pearl oyster of Ceylon beds is that of Herdman (1905, Rep. Pearl oyster. Fish.) who had reported an incidence as high as 80% at the Cheval paar, Ceylon. The only species reported by him was *C.margaritifera*, a new species. Subsequently Thomas (1979, op. cit.), based on study during the years 1969 and 1970, reported two species, *C.vastifica* and *C.celata* and the percentage of incidence reported by him was 8.5 in the natural beds of the Gulf of Mannar. No specimens of *C.margaritifera* were available in the Gulf of Mannar at that time.

Experiments on pearl culture were taken up at Veppalodai, near Tuticorin in 1972 and at Vizhinjam in

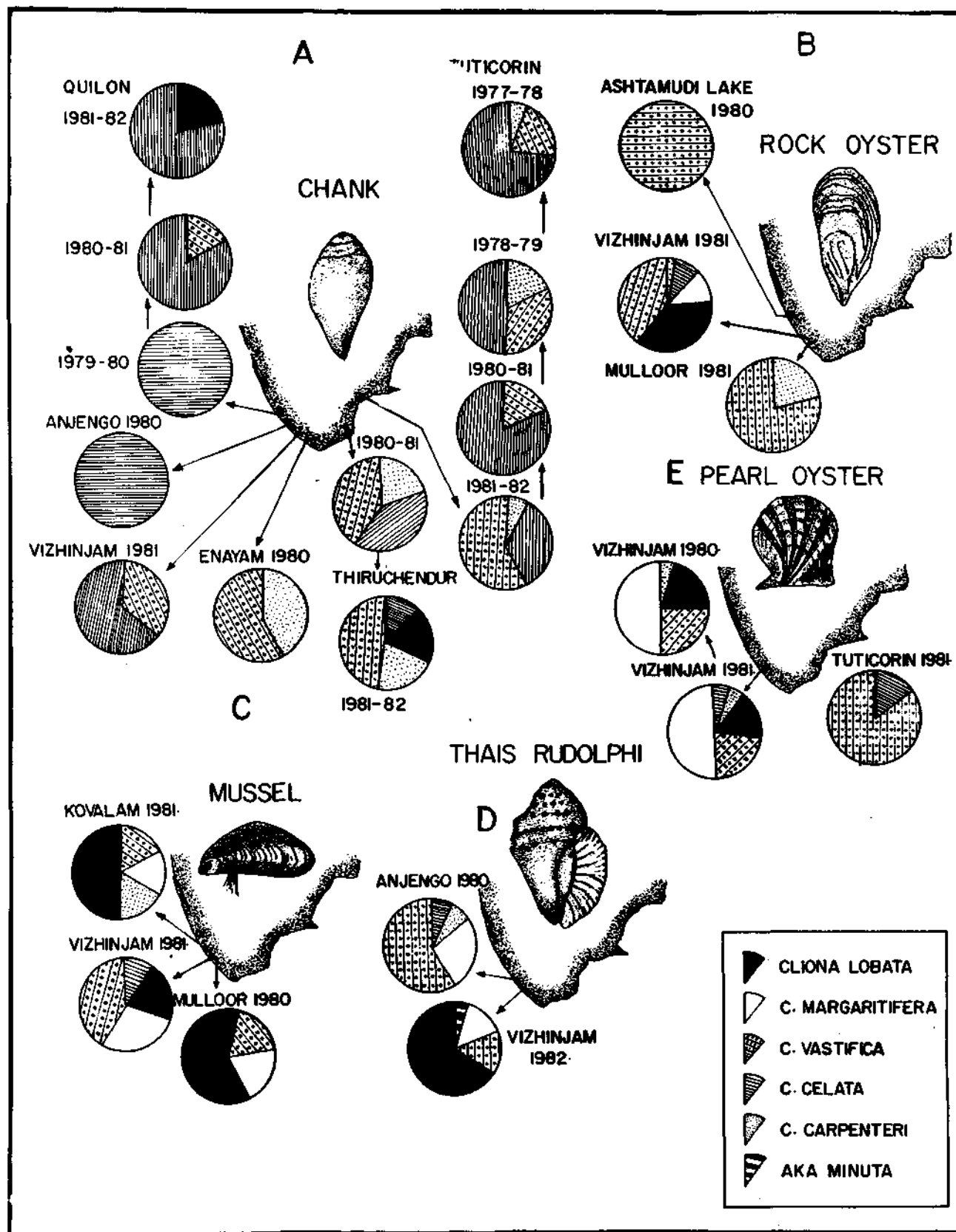


Fig. 2. A-E Abundance of different boring sponge species in chanks, mussels and oysters at different places.

1975. As a part of the investigations on the fouling and boring organisms that occur on culture rafts, Alagarswami and Chellam (1976, *Indian J. Fish.*, 23 (1 & 2) made a preliminary study and reported polychaetes, sponges, molluscs and isopods to be the major pests on the culture rafts at Veppalodai, Tuticorin. They could record only one species of sponge (*C. celata*) from the cultured pearl oysters; and this made the oyster susceptible to further damages by polychaete and other infections. The rate of infection by *C. celata*, according to the above workers, was 20%. Subsequent studies made by Thomas (unpublished data) on farm grown pearl oysters from Tuticorin during 1978 revealed the presence of only *C. vastifica* at Tuticorin. Specimens of *C. vastifica* examined during February (1978) harboured as many as 5 gemmules per chamber indicating a very high rate of autoinfection in the culture system. During 1981, another collection of cultured pearl oysters was made from Tuticorin, and the same revealed the existence of two species, *C. vastifica* and *C. celata* (Fig. 2 F). The former constituted the major pest while the incidence of the latter was rather negligible (12%).

The infection pattern of boring sponges on the cultured pearl oysters at Vizhinjam presents an altogether different picture. The incidence was found to be high at Vizhinjam when compared to that at Tuticorin: 41% of the cultured pearl oysters was found infected during 1980, whereas the same went up to 80% during 1981 (Fig. 1D).

In order to study whether the pearl oyster or the flat oyster is more prone to sponge infection, analyses were made separately for these two species. These studies revealed that *P. fucata* (pearl oyster) is more vulnerable than the flat oyster and the incidence was found to be 47 and 37 respectively. Size frequency analyses also revealed that the infection rate, in *P. fucata*, increased abruptly in higher size groups unlike in flat oysters. Size frequency (%) distribution of the total population of cultured pearl oyster and flat oyster together with the same of infected shells and those with openings inside the shell are furnished in Fig. 3, D, E and F.

2.2.2. Species of boring sponges

Five species of boring sponges were found to infest the cultured pearl oysters at Vizhinjam, and they are, in the order of abundance, 1) *Cliona margaritifera* Dendy, 2) *C. vastifica* Hancock, 3) *C. lobata* Hancock, 4) *C. carpeni* Hancock, and *C. celata* Grant. Cultured pearl oysters at Tuticorin were found infected with two species, viz. *C. vastifica* Hancock and *C. celata* Grant (Fig. 2E).

It may be mentioned in this context that *C. margaritifera* was first reported from Ceylon (Dendy, 1905, *Rep. Ceylon Pearl Oyster. Fish.*, Suppl. 18.) based on a collection made by Herdman from the pearl banks of Ceylon, in 1902. It is reported by Dendy that this sponge spread in the pearl banks almost like an epidemic and destroyed the pearl oyster beds either partly or completely. No other species of *Cliona* were reported by Dendy in his above cited report. There is sufficient ground to believe that *C. margaritifera* totally disappeared from the Ceylon beds after this great epidemic. Subsequent collections made from the Gulf of Mannar and other parts of the Indian seas in general also failed to record this species, though a few atypical or aberrant forms have been reported from widely separated areas and also from hosts other than pearl oyster. The reappearance of this highly destructive species on raft cultured pearl oysters at Vizhinjam, in 1980, hence is very interesting as it forms a major infiltration into the pearl oysters of India after a long lapse of about 80 years. Since 1980, the incidence of this species has generally been on the increase, and now a sizable fraction of the boring sponge population among the gregarious molluscs off Vizhinjam is composed of this species.

Similarly, *C. lobata* recorded from the cultured pearl oysters at Vizhinjam in 1980, also deserves mention in this context. This is a very common and wide spread oyster pest of the Atlantic and the first record of the same from the Indian seas is that of Burton (1937, *Bull. Madras Govt Mus.*, 1 (2) Pt. 4) from Pamban pas (Gulf of Mannar). But subsequent surveys failed to record this species from the Indian seas. The occurrence of *C. lobata* on cultured pearl oysters in alarmingly large numbers in 1980 (Fig. 2E) hence, pose a serious threat to the commercially important molluscan beds of Indian waters as a whole. As in the case of *C. margaritifera* mentioned above, the impact of this species is felt among all gregarious molluscs inhabiting the southwest coast of Kerala; and forms the major pest of mussel, rock oyster, and *Thais rudolphi* collected off Vizhinjam in 1982. The chanks collected from Thiruchendur beds during 1981-'82 indicate the infiltration of this species into the chank beds of the Gulf of Mannar (Fig. 2A).

2.2.3. Damage caused to the shell

When the sponge ramify the inner layers of the pearl oyster shell, it is likely to produce holes on the nacreous layer (Thomas, 1979, op. cit.), through which the sponge comes into contact with the soft parts of the animal producing lysis of the epithelial lining of the mantle. When the animal is in its actively growing phase such openings made by sponges are mended

quickly by secreting nacreous substance over these openings. Such repairs, no doubt, may cause considerable physiological strain on the host. But this situation may get still aggravated when the mollusc becomes weak due to old age or other environmental stress; and at this stage the openings formed in the inner side of the shell remain permanently open. At Vizhinjam, during 1980, pearl oyster shells above 50 mm (height) often possessed such openings inside the shell. Among infected shells, 23% of *P.fucata* and 15% of the flat oysters were in this condition. A steep increase in the number of such shells was noted during the ensuing year (1981) when about 27% of the infected shells possessed openings in the inner side. It is actually not known to what extent the energy utilised in repairing such holes will affect the pearl-producing capacity of the pearl oyster.

In conclusion, it may be stated from the past observations that the boring sponges can cause mass mortality (Herdman, 1905 op. cit.), physiological strain (Alagarwamy and Chellam, 1976, op. cit.), and suppression of growth (Chellam, 1978, *Indian J. Fish.*, 25, (1 & 2) to pearl oysters of both natural and cultured stocks.

2.3 As pests of Mussels

2.3.1 Incidence of boring sponges

Mussels, both brown and green, occurring in fishable magnitude along certain areas of the south-west of Kerala as well as the brown mussels being cultivated at Vizhinjam were investigated in detail during the period 1980-82 for boring sponges. Collections were made from the intensely fished shallow waters and also from the occasionally fished deeper beds to know the effect of fishing on the population structure and composition of the various boring communities. The maximum size of mussel from occasionally fished beds was considerably larger as against those in the intensely fished beds.

The incidence of boring sponges was found to be rather high in occasionally fished deeper beds. Collections made off Mulloor in 1980 (at 15 m. depth) recorded about 54% incidence for brown mussels and 50% for green mussels. A more or less similar figure (48%) was obtained in the case of brown mussel collected from the deeper parts of Kovalam also. Well fished beds off Vizhinjam, on the contrary, registered very low incidence (10.6%) during 1981 (Fig.1C).

2.3.2. Species of boring sponges

The following five species, in the order of abundance, were found to infest the mussels off the south west coast of Kerala during the period 1980-82: 1) *Cliona lobata* Hancock, 2) *C.vastifica* Hancock, 3) *C.margaritifera*, 4) *C.carpenteri* Hancock and 5) *C.celata* Grant.

garitifera, 4) *C.carpenteri* Hancock and 5) *C.celata* Grant.

2.3.3. Abundance and population structure

As in the case of cultured pearl oysters at Vizhinjam, the impact of the two new migrants viz. *C.margaritifera* and *C.lobata* was well seen among the mussel population also from 1980 onwards. *C.lobata* constituted the major pest in the deep water beds off Mulloor and Kovalam alike (Fig.2C), but *C.vastifica* formed the major pest in the shallow water areas off Vizhinjam. *C.margaritifera* was found to be the second largest component both in deeper as well as in shallow water beds. It is noted generally that the sponge infection starts at 60-64 mm size group onwards in green mussels. Infection by *C.celata* was rather negligible and occurred at the shallow water beds off Vizhinjam. Size frequency (%) distribution of the mussel samples analysed from different beds together with the same of infected shells in the population are presented in Fig. 3 A,B,C.

The infection of sponges was found to be nil among the farm cultured brown mussels at Vizhinjam. The reason is that the mussels are kept on rafts only for a short period (5 months on an average) and are harvested as they attain a size of 70-80 mm. In the natural condition also the infection rate is quite negligible in smaller size groups.

2.3.4. Damage caused to the shell

As in the case of pearl oysters, here also the borings are confined to the thickest parts of the shell. But in the case of those infected by *C.margaritifera* and *C.lobata*, the ramifications of the sponge, in advanced stages, may reach up to the margin of the shell. As in pearl oysters here also the tendency to pierce the inner part of the shell by the sponge was rather well pronounced, but unlike in pearl oysters no attempt by the mussel to repair these openings by nacreous material was observed. Blister formation was rarely noted among mussels.

2.4 As pests of rock-oysters (Fig. 4A).

Rock oysters (*Crassostrea* spp.) are abundantly distributed in the intertidal realms of the sea and the estuaries of the south west coast of Kerala. Specimens of rock oysters were examined from the shallow areas (0-2 m depth) off Vizhinjam, moderately deeper areas (10-15 m depth) off Mulloor, and also from the estuarine areas (Ashtamudi Lake, Quilon) for the incidence of boring sponges.

2.4.1. Incidence of boring sponges

There are no data on the overall incidence of boring sponges in the rock oyster population from the

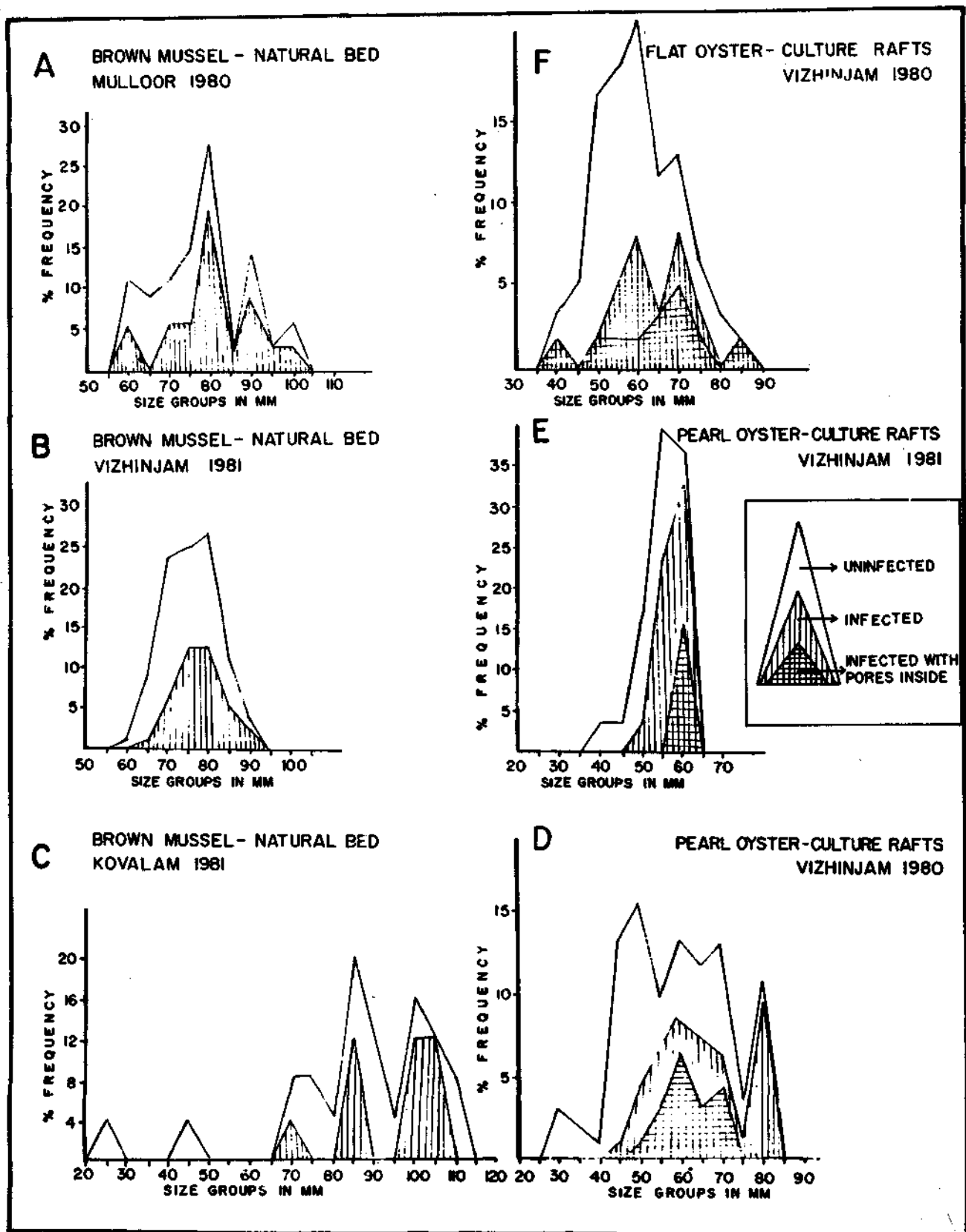


Fig. 3. A-F Percentage of infection by boring sponges in brown mussels in natural beds and in oysters in culture rafts.

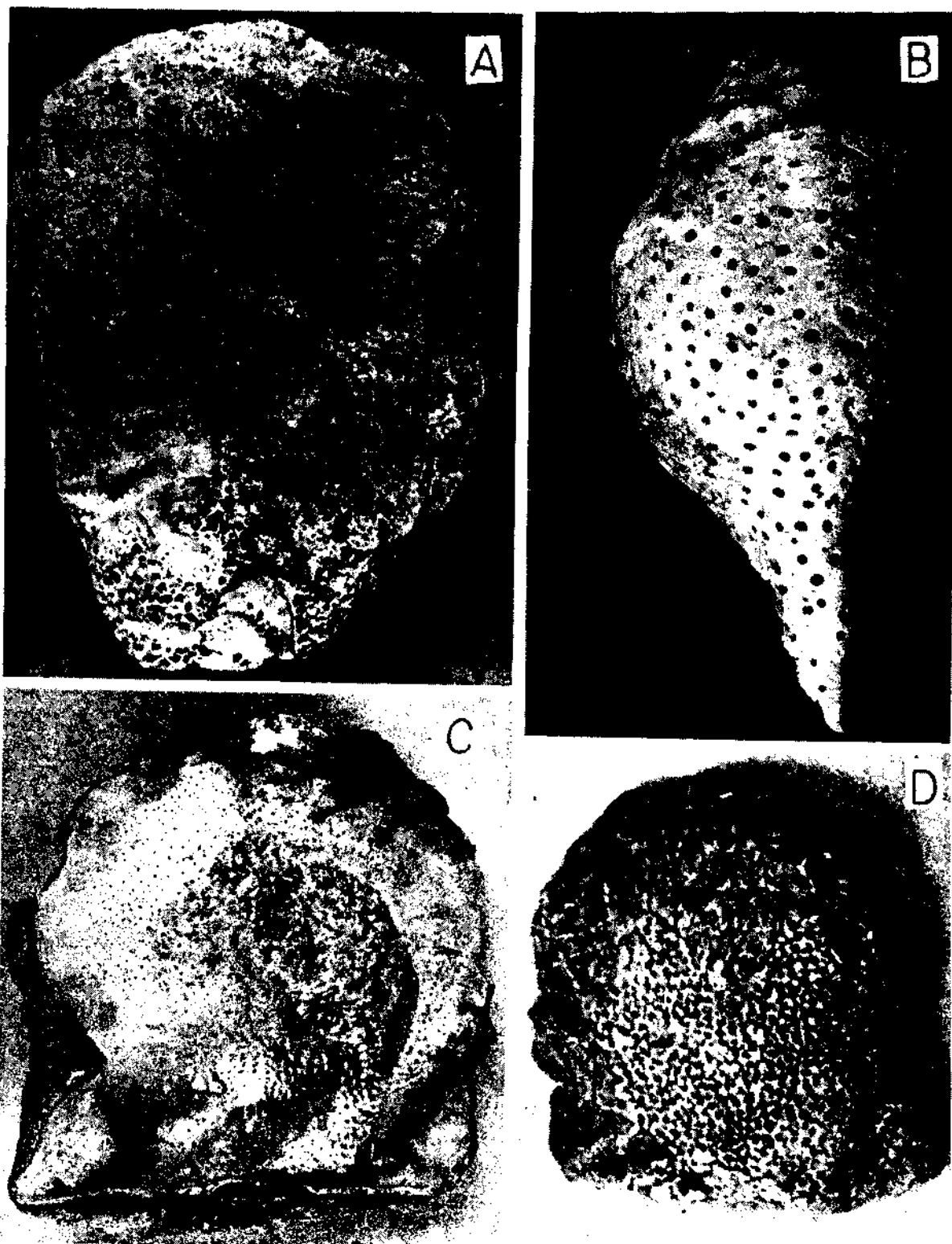


FIG. 4

- A. *Crassostrea* sp. bored by sponge
- B. *Xancus pyrum* bored by sponge.

- C. Pearl oyster shell (inner view) bored by sponge. The adductor attachment zone is eroded much and the pores made by sponge in the inner part of the shell are also clearly visible.
- D. Badly damaged pearl oyster shell (outer view).

shallow areas off Vizhinjam, but the data obtained from the moderately deeper areas off Mulloor (Fig. 1B) show that the incidence was rather high in these areas (41.6%). The estuarine areas investigated registered very low incidence (8%).

2.4.2. Species of boring sponges

Rock oysters of this area were found infected with five species of boring sponges. The various species, in the order of abundance, were: 1) *Cliona vastifica* Hancock, 2) *C. lobata* Hancock, 3) *C. carpenteri* Hancock, 4) *C. margaritifera* Dendy and *C. celata* Grant.

2.4.3. Abundance and population structure

The shallow areas off Vizhinjam exhibited rather a complex species composition (5 species) as against the deeper areas where it consisted only of 2 species (Fig. 2B). But this composition changes abruptly in the estuarine condition as there is much fluctuation in the salt content from time to time. The only species capable of tolerating wide fluctuations in salinity is *C. vastifica*, and hence this species enjoys a wider distribution in the Ashtamudi Lake.

The major pest of rock oyster in both shallow and moderately deeper areas was *C. vastifica* though its abundance varies from place to place (Fig. 2B). In shallow areas off Vizhinjam *C. vastifica* accounted for about 40% of the population while in deeper areas off Mulloor it was about 80%. A similar pattern of abundance was noted in the case of *C. carpenteri* also; in deeper areas it was five times as abundant as in shallower areas. Species like *C. lobata*, *C. margaritifera*, and *C. celata* were commonly met with in the shallow water beds only.

2.4.4. Damage caused to the shell

It is generally noted that the attached valve is infected first and thence the infection spreads to the free valve by contact. In all cases, the sponge comes into contact with the soft parts of the mollusc and possibly no effort is taken by the latter to repair these openings made by sponge. Normally when such pores are distributed densely in localised areas on the inner side of the shell such areas present an undulated appearance. Damage to hinge area of the shell as well as to adductor attachment zone was also noted.

2.5 As pests of *Thais rudolphi*

This edible gastropod is rather common in the rocky areas and is exploited at random along this coast. Samples collected from Anjengo, in 1980, as also off Vizhinjam in 1982 were utilised in the present study.

2.5.1 Incidence of boring sponges

No data are available on the incidence of boring sponges among *T. rudolphi* collected off Anjengo in 1980 as it was a sample consisting only of bored shells; but those collected off Vizhinjam in 1982 recorded a percentage of 9.7.

2.5.2 Species of boring sponges

The following five species of boring sponges were found to occur among *T. rudolphi* population in this area, in the order of abundance, 1) *Cliona lobata* Hancock, 2) *C. vastifica* Hancock, 3) *C. margaritifera* Dendy, 4) *C. celata* Grant and 5) *Aka minuta* Thomas. Of the above mentioned species, the last one is a common coral borer and is rarely met with in the molluscan shells.

2.5.3 Abundance and population structure

Samples obtained from Anjengo in 1980 were found infested with 4 species with *C. vastifica* as the major component accounting for about 60% of the population, followed by *C. margaritifera* (Fig. 2D). The other two species, viz. *C. carpenteri* and *C. celata* were found to contribute only a minor share and comprised of only 6.6% each in the boring sponge population. The shells obtained from Vizhinjam, in 1982, presented a quite different combination of species with *C. lobata* as the major pest contributing to about 66.6%. Both *C. vastifica* and *C. margaritifera*, which occupied the first and second position respectively at Anjengo in 1980, had negligible part to play at Vizhinjam in 1982. The composition of *A. minuta* was quite negligible (4.4%).

2.5.4. Damage caused to the shell

Localised attack with more preference to the thickest area was rather a general feature with regard to the sponge infection on *T. rudolphi*. An exception to this general pattern was noted in the case of those shells which were infected by *C. margaritifera* since there was a tendency for this species to ramify the entire shell. The pores produced by this species of sponge on the surface of the shell were, as a rule, smaller when compared with those produced by the same species of sponge on the shells of other molluscs. Pores, in this case, are distributed on both surfaces of the shell alike, and invariably those made inside the shell are left unrepaired resulting in the lysis of the epithelial tissue of *T. rudolphi*.

3. Molluscs (Fig. 5A)

Molluscs play an important role in excavating calcareous objects such as shells, corals, lime stone, etc. Young (1963, Amer. Ass. Adv. Sci. Publ., 75) while reviewing the studies on the boring molluscs, has given

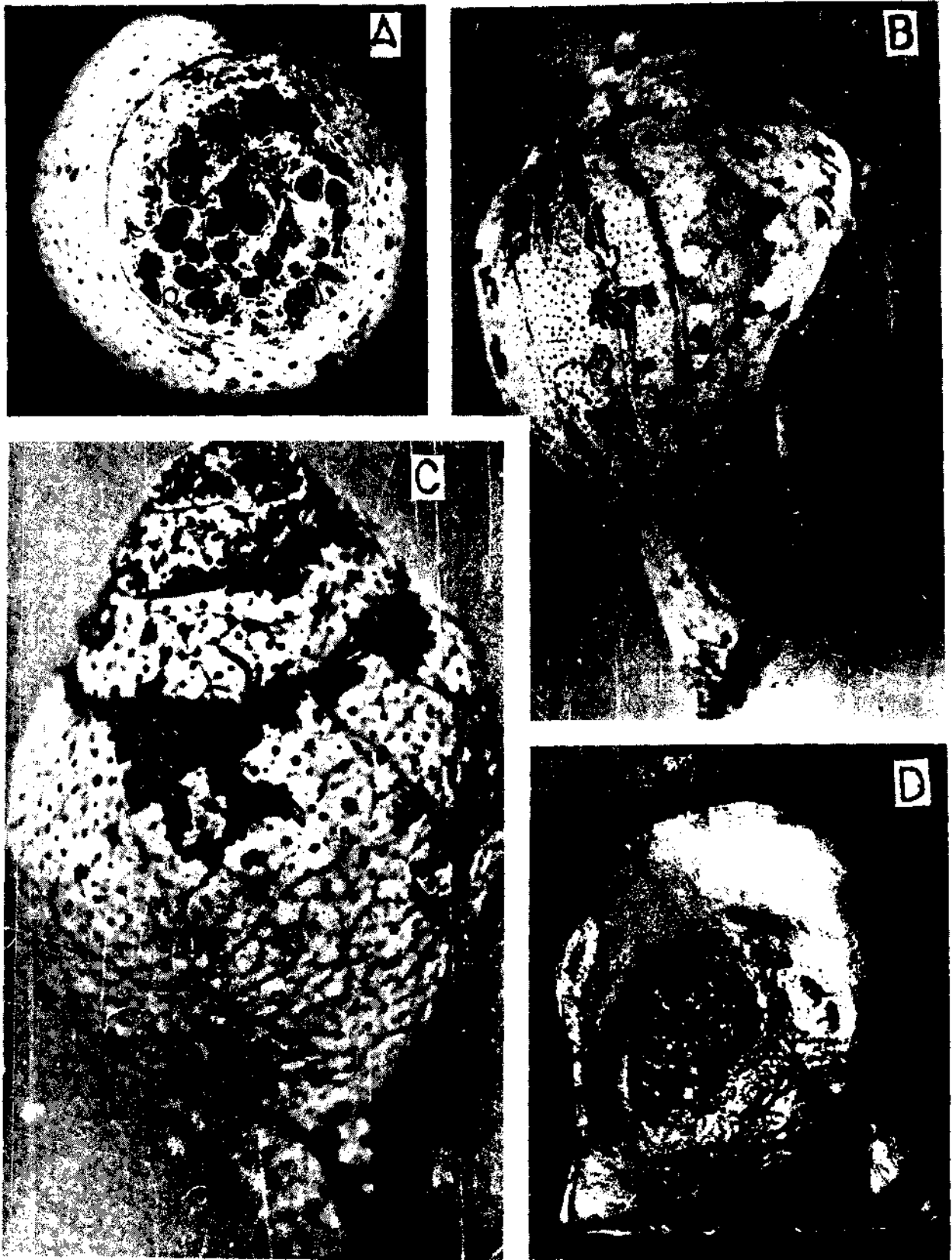


FIG. 5

A. Badly damaged apical portion of *Xancus pyrum*. Those larger openings are made by species of *Lithophaga*, while the smaller ones are made by sponge. B. *X. pyrum* bored by sponge, *Cliona carpenteri*. C. *X. pyrum* bored by *C. vastifica*. Those larger openings are made by boring mollusc, *Lithophaga*. D. Pearl oyster affected by sponge (inner view). Blisters are found at the adductor attachment zone of the shell. Pores made at the inner part are repaired at places by the secretion of nacreous substance.

sufficient details on 7 superfamilies, viz. Myacea, Adesmacea, Petricolidae, Saxicavacea, Gastrochaenacea, Cardiacea, and Mytilacea, and concluded that they have evolved independently of one another, though two major lines in their evolution - epifaunal and infaunal - could be well noticed. Appukuttan (1973, Mar. Biol. Ass. India, 15 (1)) listed 22 species of coral boring bivalves from the Indian coast. This list was further supplemented by the addition of two more species (Appukuttan, 1974, J. Malac. Soc. Australia, 3 (1); 1976, Indian J. Fish., 23 (1 & 2)) making the total 24.

3.1 Species of boring molluscs

Recent investigations on the destruction caused by the molluscs, especially the bivalves, to the commercially important chanks as well as to the coral colonies have revealed the existence of the following 6 species on the south west coast of India, 1) *Lithophaga laevis* (Q. and G.), 2) *L. bisulcata* d'Orbigny, 3) *Lithophaga* sp., 4) *Botula cinnamomea* (Lamarck), 5) *Venerupis macrophylla* Deshayes, and 6) *Diplothyra* sp.

Among these, the first 4 come under Mytilacea, the 5th under Veneridae and the 6th under Pholadidae. The first record of *L. bisulcata* from the Indian coast is that of Appukuttan (1976, Indian J. Fish., 23 (1)) and all the other species are reported herein as shell borers for the first time. *L. bisulcata*, a common shell borer in the Indian waters, is also reported here as a pest of corals. The other two coral borers found commonly at Vizhinjam are *L. laevis* and *V. macrophylla*.

3.2 Abundance and population structure

During the present study, bored chanks ranging in length from 76 to 205 mm from the Gulf of Mannar and 111 to 152 mm from the south east coast were examined. Boring bivalves were found to occur in great abundance among chanks of 125 to 205 mm, whereas those below this size group were seldom found infected. Among the various genera, the genus *Lithophaga* ranked first, dominated by the species *L. bisulcata* on chanks.

Though the rate of infection among the chunk population in both the Gulf of Mannar and the south west coast of India varied considerably from place to place, the rate was more in shallower beds as compared with deeper beds. The number of boring bivalves, in individual shell, varied from 5 to 85 in shallow water beds.

3.3 Damage caused to the shell

Both chemical and mechanical methods are employed by the molluscs for boring into calcareous substrata. Lithophags are considered by some to be

chemical borers while others attribute a chemical action initially, followed by mechanical means at a later stage. Species like *B. cinnamomea*, *V. macrophylla* and *Diplothyra* sp. bore mechanically by the rocking movement of their shell valves.

Burrows made by lithophags on shell are long and cylindrical in outline. The anterior part of the burrow, in cross section, is oval and the posterior, circular. The aperture of the burrow, in the case of *L. laevis* varies from rounded to dumbbell shaped whereas in *L. bisulcata*, it is oval. The orifice of the burrows of the young lithophags reported herein, is as a rule round and the burrow is partly or completely devoid of any calcareous coating inside, unlike in adults where it is lined by a uniform coating of calcareous matter. The burrow made by *B. cinnamomea*, on the contrary, is pear-shaped, with a perfectly round orifice; rather shallow and devoid of calcareous lining. The burrow made by *Diplothyra*, which is otherwise similar to that made by *B. cinnamomea*, may be easily identified by its mid-vertical ridge inside. Here also no calcareous lining is noted inside the burrow.

The burrow made by lithophags in corals differs considerably from that made in shells. The burrow made by *L. laevis* in coral is not lined by calcareous matter, while in the case of *L. bisulcata* the anterior part of the burrow may show traces of calcareous lining. *V. macrophylla*, often makes shallow burrows which are oval in shape and with round orifices. The posterior part of the shell, in this species, always projects beyond the general surface of the substratum.

The main target of the boring bivalves is the spire portion of the chunk. Sponges, on the other hand, pierce the entire shell giving a honey-comb like appearance to the shell in the advanced stages of infection. The shells infected by bivalves, hence, could be utilised to a certain extent by curio-manufacturers for making buttons or rings, while those riddled by sponges are entirely discarded as no part is left free and intact. At Tuticorin alone 50,000 shells, at an average, are discarded every year due to the infection of various borers.

4. Polychaetes

Though several species of polychaetes belonging to families Nereidae, Terebellidae, Spionidae, and Syllidae are known to bore into hard calcareous objects, the best known and wide-spread pests of the molluscs come under the family Spionidae and the genera *Polydora* and *Polydorella*. The common species from the Indian region are 1) *Polydora antennata* Claparede, 2) *P. hornelli* Willey, 3) *P. caeca* Osted and 4) *Polydorella prolifera* Angeuer.

4.1 Abundance and population structure

4.1.1. As pests of Chank

There is no account on the rate of infection of *Polydora* spp. on the Indian chank beds. A preliminary study made during the years 1980 to '82 showed that the infection rate of *Polydora* spp. varied considerably from place to place. At Tuticorin beds only 6.6% infection was noted during the 1977-78 season, but during the ensuing season, ie. 1978-'79, it went up to 33%. In 1980, when the chank fishery at Thiruchendur resumed after a long pause, the percentage of *Polydora* infection noted was as high as 40; but during the ensuing season it came down to 20%. The infection in the chank beds off Vizhinjam and Quilon registered 11.7% and 10% respectively during 1980-'81 season

4.1.2. As pests of cultured pearl oysters

The first authentic report on *Polydora* infection among cultured pearl oysters is that of Alagaraswamy and Chellam (1976, op. cit.). They recorded an infection rate of 20.7% at Tuticorin initially, but the rate increased considerably after one year of planting the oyster on to rafts. According to above workers, about 78.4% of the infected oysters contained blisters inside the shell. Another major hazard noted is that the *Polydora* ramifications inside the shell make it rather fragile in due course.

The *Polydora* infection noted at Vizhinjam pearl culture rafts is considerably less when compared to that at Tuticorin. During 1980 only 10% of *Pinctada fucata* and 3% of flat oysters were found infected. But subsequently (in 1981) the rate of infection increased to 23%.

4.1.3 As pests of mussels

Cultured brown mussel from Vizhinjam as well as brown and green mussels obtained from the wild were examined during the present study. Natural beds off Mulloor revealed an infection rate of 8.5%, but the infection on the raft-cultured brown mussels at Vizhinjam was practically nil.

4.2. Damage caused to the shell

These small-sized worms (*Polydora* spp.) usually form minute tubes on the surface of the shell initially agglutinating sand and other arenaceous objects. While burrowing, the animal bent the body into a 'U' shaped structure, the arms of which are separated by a partition of sand or mud or both, mixed with mucus. The burrowing is effected, at least in part, by the help of enlarged dorsal setae of the 5th setigerous segment. Whether any chemical action is involved in this process or not is not fully known.

The worm enters into the shell through a small opening made on the surface of the latter, and the entry may take place at any part of the shell. Even though several species of polychaetes exhibit the habit of burrowing into shell, only some are capable of producing simple or compound blisters inside. All species of *Polydora* fall under the latter category, and the blisters formed inside the shell often press the soft tissue and this in turn may cause malfunctioning of the epithelial tissue. In rare instances it is noted that the burrow may establish contact with the mantle cavity producing local irritation. When such openings made inside are small, the same is repaired by the mollusc secreting nacreous layer over it. But when the mollusc become old or physiologically weak the worm becomes a permanent irritant to it.

In the case of the genus *Polydora*, normally only one specimen is noted inside each blister, but in the case of the genera like *Syllis* and *Terebella* as many as four specimens could be located inside each blister.

5. Sipunculids

Sipunculids form a major group which play an important role in the destruction of dead corals and are seldom encountered in the living parts of the coral. The common species found in the Gulf of Mannar is *Dendrostoma signifer* Selenka and de Man. The usual habitat of this species is the upper strata of dead corals up to a depth of about 4 cm. The burrows made by this species are oblong in outline and the maximum size attained by this animal is 3 cm.

Though not as common as the above mentioned one, another species, *Aspidosiphon elegans* (Chamisso and Eysenhardt) is also reported from the Gulf of Mannar and this too prefers the upper strata of dead corals. This species is easily distinguishable from the former by its smaller size, say 1-1.5 cm, and dark anterior shield.

It is not fully understood whether the sipunculids obtain all or a significant part of their food from the substratum. Here the cuticular plates act as the chief organ of boring.

General Remarks

The findings presented are based on the study of boring organisms infesting the coral reefs and economically important molluscan beds of the Gulf of Mannar and the southern coast of Kerala during the period 1980-'82. The wide fluctuations noted in the abundance and population structure of the various pests in the molluscan beds during the short period of two years clearly indicate that they are in severe competition for suitable substrata and the shells of gregarious molluscs

which inhabit this area provide ample opportunities for the pests to flourish. The abundance and succession of these pests in the natural beds are always within the predictable limits for the conventional species. But on some occasions such a prediction become impossible, for the migration of unconventional species from nearby beds or the reactivation of any endemic quiescent species may totally alter the natural cycle of abundance at times. The infiltration of *C.lobata*, into Indian beds during 1980, as also the reappearance of *C.margaritifera* at Vizhinjam pearl culture rafts in 1980, may be cited as two examples denoting the two types of colonisation mentioned above. Both these species have, since then, migrated into other beds of a totally different species forming the major component in the respective beds. It is normally noted that any new infiltrant can cause a sudden spurt in the new bed, but gradually the percentage of incidence may come down and this reaction is due to the slackening in the activity of some other less competent species already existing in the bed. On the contrary, in some cases, the new migrant may multiply disproportionately resulting in epidemics. Hence it is essential to estimate the year-to-year fluctuations in the abundance of conventional species of any bed and also the impact of new infiltrant, if any, on a long-term basis.

The incidence of boring sponges is found to be rather high among raft-cultured pearl oysters both at Tuticorin and Vizhinjam. The sponge bores into the shell by chipping off the latter. When the chipping becomes intense the sponge tissue may establish contact with the soft parts of the mantle through the pores made at the inner part of the shell. The mollusc, in order to prevent such a contact, secretes extra quantities of nacreous material and repairs these holes immediately. This may, in turn, cause great physiological stress on the host. How far this stress affects the

pearl-producing capacity of the oyster is not known at present and is worth investigating.

It is rather difficult to control the infection of boring animals in the natural beds, but the low rate of incidence recorded year after year under normal conditions suggests that the nature plays an important part in keeping the abundance of these deleterious agents at a lower level, when untampered by extraneous influence. The higher incidence of boring organisms on the culture rafts, on the contrary, is an indication that the ecological inhibition which is at play in the natural beds is no longer in operation in this artificial environment. Hence any management system which places more emphasis on ecological aspects would help in cutting down the incidence of boring organisms at least to a level noted in the natural beds.

Another important observation made during the present study was the wide distribution of the boring sponge *C.vastifica* in the Ashtamudi Lake, Quilon. This species has succeeded in colonising the estuarine realms in many parts of the world by virtue of its euryhaline nature. Along the estuaries of India too, *C. vastifica* is wide spread and in estuaries like the Zuari estuary of Goa, the incidence of this species is as high as 63% (Thomas and Thanapathy, 1980, *Indian J. Fish.*, 27 (1 & 2) as against a low rate of 2-3% noted in the inshore areas of Goa. Such a high incidence of *C.vastifica* in the estuarine condition may, apart from its euryhaline nature, be due to the availability of the shells of *Crassostrea* spp. in plenty. Hence there is every possibility that this species (*C.vastifica*) may form a major threat to our future rock oyster farms along the estuaries.

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CLASH BETWEEN PURSE SEINE AND ARTISANAL FISHERMEN AT COCHIN*

The commercial purse seine fishing operations commenced in Kerala towards the end of 1979 and at present about 60 purse seine units are operated from Cochin base. The introduction of purse seining in Kerala in the traditional grounds has been vehemently opposed by the indigenous fishermen and has, on many occasions, resulted in skirmishes between the two from the very beginning. In order to minimise the tension prevailing between the mechanised and non-mechanised fishermen and as a step towards a better management of the pelagic fishery resources of Kerala coast, the Government of Kerala enacted the Kerala Marine Fishing Regulations Act, 1980. As per provisions contained in the act the area of operation of each type of vessel is clearly demarcated. No mechanised craft is permitted to fish upto 8 fathoms. Countrycrafts and catamarans fitted with outboard motors can operate from 8 fathoms. Mechanised boats of less than 25 gross tonnage, are restricted to operate between 10 and 20 fathoms and purse seine boats are permitted to fish only beyond 22 fathoms. The purse seine boats if caught fishing in banned waters can be fined upto Rs.5000/- or the catch confiscated and the fine increased to five times the cost of the catch.

Recently the Government of Kerala started strict enforcement of the Act. In September 1982 the State Fisheries Department seized 6 boats which were found fishing in banned waters and fined Rs.2,000/- each. As a protest against the seizure of the purse seine vessels by the Fisheries Department authorities, the Purse seine boat Owner's Association along with Purse seine boat Thozhilali Union observed one day hartal on 16.9.82, with the support of Cochin Fisheries Harbour Thozhilali Union, Buying agents and merchants' Association, Fisheries Harbour Merchants' Union etc. They also staged a 'dharna' in front of the Office of the Deputy Director of Fisheries, Government of Kerala, Ernakulam. The purse seine boat operators feel that the Kerala Marine Fisheries Regulation Act banning purse seining within 22 fathom zone is impractical, unrealistic and unscientific and point out that purse seining in nearby Karnataka and Goa is banned only within 5 km (8 fathoms) of the sea coast.

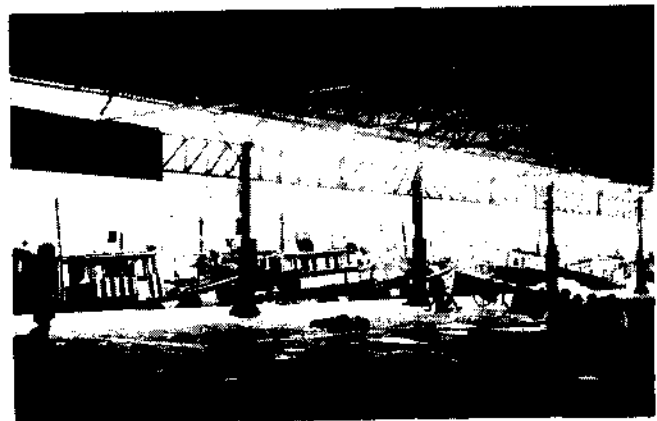
On 2.11.82 a purse seine boat 'Achumon' was set on fire and sunk off Vypeen Island near Nayarambalam by irate artisanal fishermen. The indigenous fishermen employing thanguvala in country crafts of Puthuvypu,

Nayarambalam and Munambam fishing villages are of opinion that due to the operation of purse seine boats the sea has turned barren for them. According to them the purse seine boats operate all over the inshore areas and seldom beyond 22 fathom line and as a result they are finding it difficult to operate the thanguvala units economically. Normally the purse seine units operate from very early in the morning making on an average 3-4 hauls daily. The catch is lifted out and transported to the base by carrier vessels, while the purse seine continues to operate in the fishing ground. By the time the catch of the indigenous fishermen reach the coast, the supply would have far exceeded the demand. The special survey conducted by the Central Marine Fisheries Research Institute to find out the impact of the purse seine operations on indigenous fisheries also showed that before the introduction of purse seining traditional fishermen were able to get higher prices, whenever the catch was less. However, the effect of purse seining at the present level of exploitation and availability was not tangibly felt on the indigenous fishery off Kerala coast (Jacob et. al. *Mar. Fish. Infor. Serv. T & E Ser. No. 40*, 1982).

In protest against the burning of the purse seine on 2.11.82 all the purse seiners at Cochin Fisheries Harbour struck work from 3.11.82. The increased violence of the traditional fishermen against purse seine fishermen had also recently resulted in the burning of the boats 'Veera Ratna' and 'Mahalakshmi'. The strike continued for more than a week, upto 10.11.82. As a consequence of this the Fisheries Harbour had a deserted look (Vide Photographs). With the already reduced activity of drift gill nets and shrimp trawlers at the Fisheries Harbour due to poor catch and as the protest strike by the purse seiners also continued a near fish famine was felt at Cochin and adjacent areas, with the cost of fish skyrocketing.

During the purse seining season about 55-60 purse seine units are operated from the harbour bringing an average catch of 100 tonnes of fish per day. The average estimated loss of catch during the strike period would have been about 800 to 1000 tonnes of fish consisting mostly of small sized oil sardine in the size range of 95-120 mm, as assessed from the trend

*Prepared by K.V.Somasekharan Nair and A.A. Jayaprakash with the guidance of K.V. Narayana Rao.



Purse seiners and carrier boats lying idle at Cochin Fisheries Harbour due to strike on 3.11.82.

of purse seine landings immediately prior to and after the strike. The price of juvenile sardine fluctuated between Rs.500/- to Rs.800/- per tonne indicating that the total loss during the strike period would have amounted to between Rs.5.2 to Rs.6.5 lakhs. There was good demand even for cheap and trash fishes like small carangids (mainly *Alepes kalla*), juveniles of small sized sciaenids (*Johnieops dussumieri*, *J.sina*, *Kathala axillaris* and *Otolithes ruber*), flat fishes (*Cynoglossus macrostomus*) etc. which were marketed for prices ranging from Rs.1.5 to 2.0 per kg. Usually when there is good purse seine landings, these catches are mainly used for drying and very seldom marketed fresh. The price of quality fishes like pomfrets and seer fishes shot up. The purse seine strike made a majority of the nearly 5,000 workers employed at the Fisheries Harbour in connection with the handling of fish catches under employed. On an average 17 hand carts, 47 auto trucks, 154 bicycles, 24 tempos and 35 lorries come to the harbour every day. The production of ice in the factories near Cochin also was greatly reduced.

While the purse seine boat fishermen condemn the State Marine Fishing Regulation Act demarcating the area of fishing for purse seine boats, the traditional fishermen insist that if the law is not strictly enforced the traditional fishermen would become extinct due to starvation. The purse seiners while steaming out for fishing from the harbour very early in the morning often sight shoals very near the shore, which they usually fish. Off fishing villages like Puthuvypu, Nayarambalam, Vypeen etc. the operation of purse seine boats can be seen even from the shore, which generally leads to tension between the indigenous and purse seine fishermen. It may also be noted that the motorisation of the country crafts with out-board engines has also not picked up to the same extent in these villages, as in the fishing villages of south Kerala.

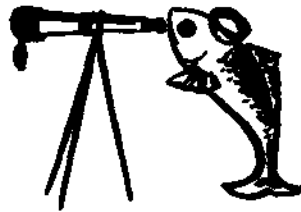
The purse seine boats resumed fishing operations from 10.11.82 based on the discussions held at Trivandrum between the boat owners and the State Government authorities. However only few units ventured into

the sea for fishing fearing attack from the artisanal fishermen; the number of purse seines operated on that date being only 6 with 12 carriers. Their catch consisted of mainly juvenile oil sardine in the size range 95-120 mm. On 11.11.1982 there was no operation of purse seine boats from the harbour. However, from 15.11.1982 all the purse seines started fishing and landed good quantities of oil sardine. In December 1982 the State Fisheries Department impounded 15 purse seine boats for fishing in the prohibited waters. All these boats were fined Rs.5,000/- each. The tension between artisanal and purse seine fishermen is also continuing unabated. On January 10, 1983 members of some associations of the artisanal fishermen of nearby fishing villages of Cochin staged a 'dharma' at Ernakulam demanding total ban on purse seine fishing. Perhaps, due to some of these factors and pressures, some of the purse seine units have already shifted the area of operation from Kerala coast. At present only about 25-30 purse seine boats are operated from the Cochin Fisheries Harbour per day, whereas about 55-60 units were fishing daily in 1981 and 1982.

Banning of purse seines in Kerala cannot be considered a long range solution for the problem. The Kerala coast is rich in pelagic fish wealth. Sardines and mackerels are the most important pelagic fishes as far as the traditional fishing methods are concerned. The

indigenous fishing crafts alone cannot exploit the entire resources and if so left to them, the cost of fish is bound to skyrocket. In order to minimise the resentment of the artisanal fishermen to purse seine fishing, the patrolling of the sea to check fishing in the banned area should be intensified. But the fisheries department is helpless due to lack of infrastructure and manpower. The moment a patrol boat is cited the purse seine boat leaves the catch and speeds away. So proper petrolling in order to prevent the purse seiners operate in the banned area is a great necessity.

At present there is no co-operative society for fishermen in this area. As in the case of all other trades, the middlemen are exploiting the fishermen who actually undergo all the hardships in the sea and get only a meagre share. One possible way of aiding these fishermen is that the Central and State Governments and scheduled banks should extend liberal credit facilities to artisanal fishermen both on individual and co-operative societies and each such society can be entrusted with a limited number of purse seine units which should operate within the specified area. This will also help in spreading out the purse seine fishing effort more uniformly along the coast, preventing unhealthy concentration of fishing effort in certain specified areas and would probably help in minimising the conflict between the fishermen.



SPURT IN FISH LANDINGS ALONG NORTH TAMIL NADU COAST*

In the second fortnight of August, 1982 a sudden spurt of unusually heavy fish landings was noticed along the northern part of Tamilnadu coast extending from Pondicherry to Madras. Some of the species of fishes represented in the catches being occupants of deeper water, a probable movement of deep water fishes into the inshore areas has occurred during this period. Certain details of the landings of a few centres along the coast during the time are presented.

Pondicherry

The heavy fish landings were observed from 17.8.1982 to 31.8.1982 in landing centres adjacent of Pondicherry, viz., Chinnamudaliarchavadi, Nochikuppam, Cholakandikuppam and Kanakachettykuppam. The catches comprised mainly of *Caranx* spp., *Soles*, *Nemipterus* spp., *Saurida* spp., cuttlefish and coral fishes and were fished by indigenous gears like bag net, shore seine, gill net and boat seine.

The landings ranged from 0.5 to 6.5 tonnes per day (Table.1). Due to the heavy catches, there was glut in all the landing centres of this region, resulting in very low market value for the fishes. For instance, the normal cost of *Decapterus* sp., about Rs.3 per kg. fell to Rs. 0.75 per kg. Consequently the fishermen did not go out for fishing for a day or two in some of the landing centres.

Kovalam

Whereas the temporary heavy landings lasted for about 15 days in Pondicherry region, the same was noticed in Kovalam region only for 2 days, viz., on 23.8.'82 and 24.8.'82. On 24.8.'82, about 3.3 tonnes of fishes were landed at Kottivakkam, mainly by shore seines (2 units). Of the 3.3 tonnes landed here about 2.3 tonnes were constituted by *Leiognathus bindus*.

At Kovalam landing centre, about 2.3 tonnes of fish were landed by boat seines (31 units). The catch consisted mainly of coral fishes, *Leiognathus* spp., *Nemipterus* spp., *squilla* spp., and *Sepia* spp. Interestingly some of the fishes, crabs and prawns, which normally inhabit deep waters were caught in boat seines operated in 4 m depth on that day

Fishes: *Psenes indicus*, *Chaetodon vagabundus*, *Holocentrus rubrum*, *Pseudorhombus triocellatus*, *Plectorhynchus pictus*, *Apogon multitaeniatus*, *Archamia lineolata*, *Scolopsis vosmeri*, *Pempheris moluca*,

Opisthognathus muscatensis, *Ichthyos copus*, *Synaptura zebra*, *Caesio caerulaureus*, *Abudefduf* sp., *Alectis indicus*, *Hoplobrotula* sp., *Brotula maculata* and *Epinephelus tauvina*. (Fig.)

Prawns: *Metapenaeus monoceros*, *Parapenaeopsis* spp., and *Trachypenaeus* sp.

Crabs: *Portunus hastoides*, *P. gladiator*, *Charybdis*, *Callinassa*, *Dorippe* (*Dorippoides*) *jacchino*, *Philyra globulosa*

Madras

Similar rise in landings were observed in Madras also. At the Kasimedu landing centre for mechanised trawlers there was an abrupt increase in landings from 26.8.1982 lasting upto 30.8.'82 (Table 1). On these days the landings ranged from 30 to 44 tonnes per day. In the previous month of July the average landing was 22 tonnes per day, thus recording 1.5 to 2 fold increase in fish landings during this period. The major constituent in the catch at Kasimedu was *Nemipterus* spp. While *Nemipterus* spp. formed 17.1% of total trawl catch in July, the percentage composition of these fishes rose to 49.3 on these days. A few specimens of *N. metopias*, which is rarely recorded from these waters were also present. *Saurida* spp., *Sepia* spp. and coral fishes were the other varieties represented in the catches. Most of the private boats operated in inshore waters (15 m depth) during this period.

Environmental conditions

During the period of high landings it was noticed that there was a slight fall in surface water temperature along the north Tamil Nadu coast. The average surface water temperature off Kovalam dropped to 26.8°C on 24.8.'82 from the normal average temperature of 29.1°C recorded during the period from 1.8.'82 to 22.8.'82. Swarms of *Noctiluca miliaris* were also observed on 24.8.'82, one of the days of high landings of fishes.

Results of analysis of water samples collected off Madras on two days of heavy landings, making use of Cadalmin III are presented in Table 2. A notable feature is the low oxygen concentration (1.10 to 1.37 ml/l) and low temperature (26.2 to 27.2°C) during

*Prepared by E. Vivekanandan, M. Kathirvel, V. Selvaraj, K.G. Girijavallabhan, M. Rajagopalan and L. Chidambaram



Fig. Some species of fishes caught during the fortnight

Table.1. Estimated landings (in kg) at different centres of north Tamil Nadu coast during the second fortnight of August, 1982. (Major categories in the catch in parentheses)

Date August 1982	Pondicherry	Kovalam	Kasimedu (Madras)
17	2,000 (<i>Caranx</i> , <i>Nemipterus</i>)	175 (<i>Trichiurus</i>)	No data
18	5,000 (<i>Caranx</i> , Soles, Coral fishes)	No fishing	-do-
19	4,000 (<i>Sciaemids</i> , Soles, Coral fishes)	100 (<i>Dussumieria</i>)	18,420 (<i>Nemipterus</i> , <i>Saurida</i>)
20	No data	No data	No data
21	-do-	-do-	-do-
22	-do-	-do-	-do-
23	No fishing due to glut	500 (Coral fishes, <i>Nemipterus</i>)	20,978 (<i>Nemipterus</i> , <i>Sepia</i>)
24	6,500 (Soles, Rays, <i>Saurida</i>)	2,300 (Coral fishes, <i>Nemipterus</i>) 3,300 (at Kottivakkam) (Silverbellies)	No data
25	3,000 (<i>Upenoides</i> , <i>Serranus</i>)	25	-do-
26	500 (Coral fishes)	8	43,917 (<i>Nemipterus</i> , <i>Saurida</i>)
27	No data	82 (Tuna)	30,104 (<i>Nemipterus</i> , <i>Sepia</i>)
28	-do-	80	No data
29	6,000 (<i>Epinephelus</i>)	No data	-do-
30	No data	-do-	33,370 (<i>Nemipterus</i> , <i>Sepia</i>)
31	-do-	-do-	16,974 (<i>Nemipterus</i> , <i>Saurida</i>)

Table. 2. Hydrographic conditions in different areas off Madras

Date August '82	Station	Depth (m)	Dissolved O ₂ (ml/l)	Temperature (°C)	Salinity (‰)	Plankton
20	12.80/6B	10 Surface Collection	1.10	26.2	34.3	Swarm of <i>Noctiluca miliaris</i>
	13.80/1C	30 Surface Collection	1.37	27.2	34.0	-do-
	13.80/1C	30 Bottom Collection	No data	27.2	33.3	—
30	12.80/6B	30 Surface Collection	1.31	27.2	34.3	Swarm of <i>Noctiluca miliaris</i>

these days. In the month of July the average oxygen concentration off Madras was 3.53 ml/l and water temperature 29.2°C.

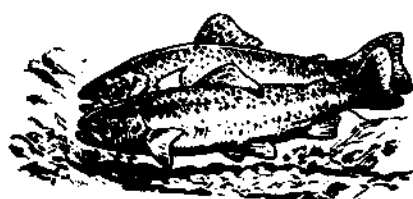
Analysis of plankton samples (horizontal and oblique collections) collected on 20.8.'82 and 30.8.'82 in the areas mentioned in Table 2 revealed swarms of *Noctiluca miliaris* on both days. In a subsequent collection on 4.9.'82, a bloom of *Chaetoceros* sp. was observed.

Remarks

The increased landings were observed off Pondicherry from 17.8.'82, off Kovalam on 23 & 24.8.'82 and off Madras from 26.8.'82, pointing to a possible drift in the commencement of the heavy landings from south to north direction in the northern part of Tamil Nadu

coast. This might probably indicate that the sudden movement of the slightly deeper water inhabitants of the coast caused by some unknown factor struck the coast in the southern area first and slowly moved towards the north upto Madras. There are indications that this unknown factor may be the sudden upwelling taking place in this area. The swarming of *Noctiluca* sp. along with fall in temperature at the time of high catch would suggest the occurrence of upwelling, driving the demersal fishes towards the shore.

We are thankful to Dr. B. Krishnamoorthi for going through the report and offering valuable suggestions. The help rendered by S/Shri M.Bose, S.Chandrasekar and T. Dhandapani is gratefully acknowledged.



EXPLOITATION OF CLAM SHELL DEPOSITS IN THE KUNDAPUR ESTUARY*

The Kundapur estuary is the largest estuarine system in the Dakshina Kannada district of Karnataka with a water spread of about 26 sq. km, situated about 100 km north of Mangalore, and is important for clam landings. Till recently the sub-soil shell deposits in the estuary were exploited on a very limited scale due to poor demand. The establishment of a polyfibre industry in Harihara has opened up a new avenue for lime shell utilisation and, consequently, lime shell production has attracted the attention of poor people. The introduction of a simple but effective device for collection of clam shells in 1975 proved to be a turning point in the exploitation of the resource. The shell deposits are comprised of *Meretrix casta* - 40%, *Meretrix meretrix* - 25%, *Paphia malabarica* - 25% and others (*Anadara Cerethedia* and oysters) - 10%.

Description of shell dredge

The dredge used for the collection of shell deposits is locally called "machine" (Fig.1). It consists of a semicircular iron ring, to the free ends of which is fitted a slightly curved iron base plate of about 42 cm length, having 19-20 spikes pointing downwards. The height of the plate with spikes is 4.5 cm. To the middle of this spiked plate, an iron piece (about 13 cm length) is rivetted to which a wooden piece of about 60-65 cm is attached. A bamboo pole, 6.5 m long, is tied to the wooden piece. An iron chain of about 3 m length is rivetted to the free ends of the ring. To the middle of this chain a nylon rope of about 10-11 m is tied. The arrangement facilitates dragging of the dredge over a pulley attached to the boat. A net is attached to the device to hold the shells being dredged. To the cod end of the net a 2m rope is tied on the inside, which could be pulled up and down for cleaning the shells.

Operation of dredge

A pair of boats is employed for the operation of the dredge. Each boat is manned by two persons. Usually they go out for collection early in the morning and return by mid-day. Initially the estuarine bed is sounded to detect the shell deposits. The shell collectors thrust a bamboo pole into the bed till the shell layer is reached and drive it deeper to know the thickness of the bed which is measured by the sound made by the thrust of the pole through the shells. The prospecting is usually not carried out daily as one site may yield shells for a few days.

Each boat is tied to 2 to 3 casuarina poles fixed in the river bed. The second (rear) boat is positioned parallel in line with the first boat in such a way as to leave a gap of 1 m in between, also lying 1 m to the left of the first boat. The dredge is driven well into the bed from the first boat and the rope is pulled up over the pulley in the rear boat. A person in the first boat takes charge of the cleaning rope. The dredge is pulled to collect the shells which are cleaned by lifting the cod end of the net. Then the shells are emptied into the first boat. Each operation normally takes 2-3 minutes. In a single operation about 10 to 20 kg of shells are hauled up depending upon the thickness of the shell layer. The boats used for collection of shells are usually of 1 tonne capacity. Each site may yield shells for one or two weeks before it gets exhausted. The site again becomes productive after a couple of months or more, with the filling of shells due to movement of the loosened layer of shells around it.

Shell Production

A unit of a pair of boats collects about two tonnes of shells a day. There are about 85 units operating in Kundapur estuary. During the south-west monsoon season the number of units may be as high as 125, as the fishermen gets a gainful occupation during the off season. The total production of shells varies from 150 to 175 tonnes per day. Boats of 10 tonnes capacity are used for transporting shells from the collection sites to the selling point. Mechanised shell washers with running water are used for further cleaning shells. In this process small broken pieces of shells, sand and mud constituting about 10-15% are removed. A co-operative organisation "Swawalambi Sangh" of Kundapur, purchases all the lime shells directly, eliminating the middlemen, and thus protects the economic interests of shell collectors. The shells are sold by the Sangh at Rs 85-100/tonne at Kundapur.

The estimated production of lime shells in Kundapur estuary during 1975 to 1982 (July-June) is given below:

Year	Production (tonnes)
1975-76	13,500
1976-77	21,540
1977-78	22,000

*Prepared by G. Syda Rao

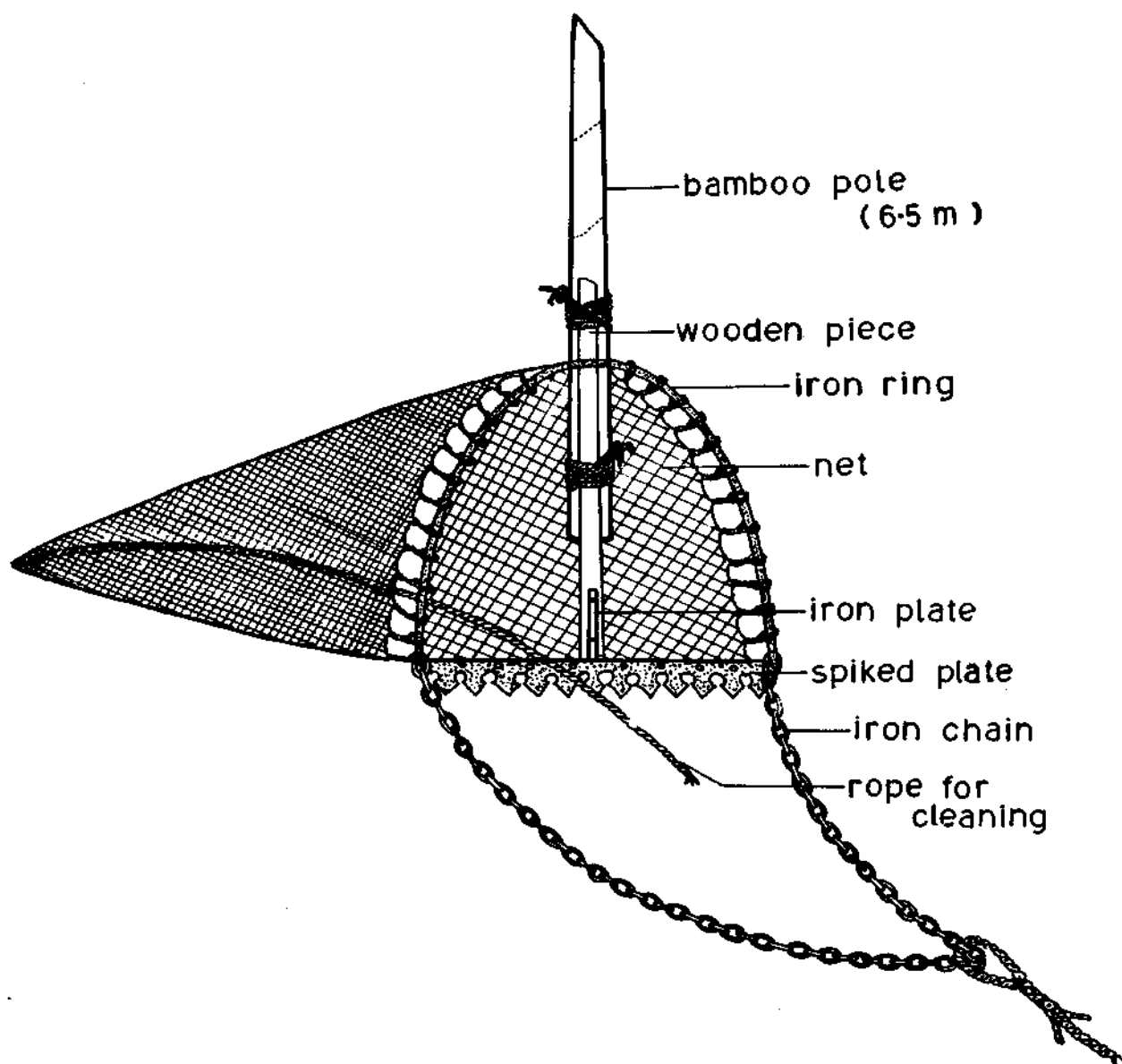


Fig.1. Construction details of shell dredge.

1978-79	19,680
1979-80	22,470
1980-81	29,540
1981-82	14,325
1982-83	6,000
(Upto Dec. '82)	

Utilisation

As stated earlier the major user of these shells is the Harihara polyfibres. The shells form an important component of 'Chemical recovery process' in most of the pulp (paper and rayon) industries. The shell lime is also

used for treatment of effluents, to neutralise soils of coffee and tea plantations, and as a pesticide by mixing with copper sulphate. The finer bits of shells are mixed in the poultry feed.

Present status of shell collection

About 450 people are employed practically throughout the year. At present the shell collection is concentrated around 'Uppena Kuduru' is let in the estuary. This estuarine area is about 138 ha and was leased out for 20 years, by the Department of Mines and Geology, Government of Karnataka to the first five



Fig.1 General view of Kundapur estuary, showing a number of units engaged in shell collection



Fig.2. Dredge, locally called "machine", hauled with shells.



Fig.3. Close-up view of the pulley attached to the rear boat to pull up the dredge.



Fig.4. A view of heaps of cleaned shells near a lime factory at Kundapur.

years and Rs.36, during the rest of the 15 years. Further, they have to pay Rs.4/tonne of exploited shells as 'royalty'. In addition to Kundapur estuary, about 247 ha in the Byndoor estuary and 293 ha in the Udyavara estuary have already been leased out for the exploitation of shell deposits. The deposits are noticed 1 to 1.5 m below the soil and the height of water column over the bed varies from 1.5 to 3 m.

General remarks

Very rarely a few live clams are found in the dredge collections at present, indicating absence of clam beds. But this area was known to yield good quantities of live clams, particularly *Paphia malabarica*, till 1978-79. Continuous dredging might have disturbed

the substratum and prevented the settlement of clams. Extensive operation of dredge has adversely affected one of the clam beds in the sea between Gangoli and Uppena Kuduru. Regulatory measures are necessary for proper management of clam resource in these estuaries keeping the long-term benefits in view.

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PROVEN TECHNOLOGY

6. TECHNOLOGY OF OPEN-SEA MUSSEL CULTURE

Highlights: A technique for the culture of the green mussel *Perna viridis* in the open sea has been developed. Mussel seed collected from the intertidal rocky beds and/or produced in the mussel farm through spat collection on ropes are securely wrapped around ropes. The seeded ropes are suspended from rafts moored in the sea at a depth of 8-10 m. The seed mussels get attached over the ropes within one or two days. The growth of mussels in the farm is faster compared to the mussels in the over-crowded natural beds. In the farm they reach the harvestable size in five months from seeding. The production per metre length of rope is 10-12.3 kg of mussels and the cultured mussels give a meat yield of upto 40 per cent. Such high production is possible due to the three dimensional culture where in the entire water column below the raft is used for production and the mussel feeds directly on primary producers namely phytoplankton. The technique for the culture of brown mussel *Perna indica* is the same as for the green mussel.

Operational details: Mussel culture in the open sea is done from floating rafts varying in size from 5 x 5 m to 8 x 8 m. The rafts are constructed using teak and bamboo poles lashed together with ropes and are mounted on 5-6 cylindrical metallic floats of 200 l capacity to get the correct buoyancy. The raft is moored in the open sea at 8-10 m depth by 2 anchors each of 100 kg and anchor chains of length 3-4 times the depth.

Collection of mussel seed for the farm is done from the intertidal mussel beds after the peak spawning season. One can easily collect about 10-20 kg of mussel seed in an hour. The average seed size for farming is 15-25 mm and 600 g seed are required for seeding one metre length of rope. Synthetic and coir ropes of 15 to 20 mm diameter are suitable for growing mussels from the rafts. An optimum number of 60 ropes each having 6 m seeded length can be suspended from a standard raft of 6 x 6 m. After suspension of ropes, the mussel culture farm needs only minimum attention to see that the rafts are in position and in good shape and the ropes with growing mussels remain hung properly. Growth of the mussels in the farm at Calicut ranges 11.6-12.9 mm in length and 5.9-7.3 g. in weight per month. A production rate of 10-12.3 kg per metre length of rope would be possible, which is about 20 times the average seed weight. Harvesting is done at the end of 5 months by bringing the ropes ashore with

the help of the canoes and removing the mussels. The mussels are cleaned of all the fouling organisms such as barnacles and are depurated in clean sea water before they are marketed.

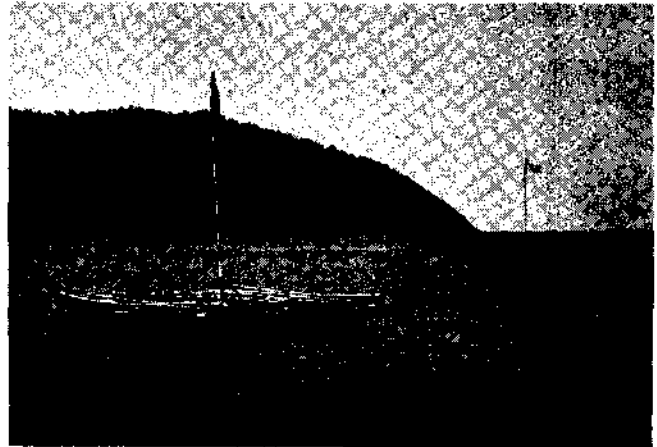


Fig.1 Mussel culture rafts moored in the sea

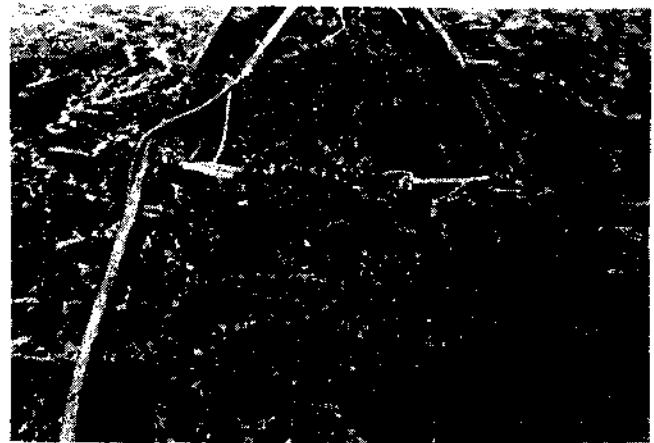


Fig.2. Canoe loaded with ropes bearing cultured mussels harvested from the farm

Production: One standard raft of 6 x 6 m holding 60 ropes will produce 3600 kg whole mussels or 1260-1440 kg meat.

Investment and cost: The materials required for a standard raft are 10 teak poles, 12 bamboo poles, 2 anchors, 2 anchor chains and 70 kg nylon ropes. These capital items will be good for 3 years except anchors which will have a longer life and the expenditure on these will be Rs.5500. Contingent expenditure on floats, knitted cotton cloth, seed collection, seeding,

maintenance and labour for operation of one raft will be Rs.4500 for 3 years. The total cost for 3 years would be Rs.10,000

Turn over of mussel farm: In a three-year mussel culture project, total production from each standard raft would be 10 tonnes of whole mussels. At an average cost of Rs.2000 per tonne the turn over will be Rs. 20,000.

Constraints and prospects: Considering the rough sea conditions prevailing during monsoon, open-sea mussel farming can be carried out only during part of the

year for a single crop. Technology for year-round mussel culture is under development. Availability of seed for large-scale farming is a serious constraint. The natural mussel beds can provide seed on a limited scale. Technology for hatchery production of seed is being developed to overcome the seed problem. Marketing aspect has to be looked into as mussel is a popular food only in some coastal sectors. A small export potential for processed mussel meat exists. In view of the very high production rate, mussel culture holds great promise for increasing protein-rich seafood production.



NEWS — INDIA AND OVERSEAS

Unusual catches of squids in Orissa coast

Along the coast of Ganjam District in Orissa, the shore seine operations generally commence in September and last till April. In 1982, the season prolonged upto June. The shore seines are operated at a distance of about $\frac{1}{2}$ km to 1 km from the coast at a depth of 5 to 10 m. Usually the squid, *Loligo duvaucelii* contributes to a maximum of 4-5 kg per unit in the shore seine catches along the coast during the period. Unusual catches of squids occurred here in March and April 1982, the shore seines landing about 20-25 kg per unit on most of the days. About 30 shore seines which operated on 29.4.1982 along the Gopalpur coast between Bandar and Bakshipeta landing centres were estimated to have landed nearly 1 tonne of squids. Such unusual landings of squid had not been witnessed in this area before.

Reported by Ramasomayajulu and K.Dhanaraju Juvenile whale sharks landed

Most of the records of occurrence of the whale shark *Rhincodon typus* Smith from Indian coastal waters are from the southeast and southwest coasts. There were five earlier reports of the capture of the species from the east coast and three from the west coast. The present report deals with the capture of the two specimens of the whale shark from Keelakarai in the Gulf of Mannar.

One of the specimens was caught by fishermen on 7.2.1983 at 4.00 hrs in gill net (Pachi valai) operated by a thirty foot length mechanised boat near Appa Islands



Fig 1. Whale shark *Rhincodon typus* Smith landed at Keelakarai

at about 20-30 m water depth. The net was partly damaged while bringing the whale shark by the mechanised boat to the shore at 11.00 hrs. The whale shark measured 4 m in length and weighed about 2 tonnes. The specimen was cut into pieces immediately after landing and buried in the sea shore. Thus morphometric measurements and other details could not be collected.

The other specimen was caught on 23.2.1983 at 16.00 hrs in a gill net operated by a non-mechanised boat and towed to the Keelakarai landing centre. The whale shark was a male, measuring 4.75 m and weighing about 2.5 tonnes (Fig.1). The body measurements of this specimen are as follows:



Fig 2. Whale shark landed at Karwar.

Morphometric characters	Measurements (cm)
Total length (Snout to the tip of caudal)	475
Tip of snout to origin of first dorsal	247
Tip of snout to origin of second dorsal	348
Tip of snout to origin of anus	298
Maximum height of the body	200
Height at the second dorsal	133
Height at the caudal origin	68
Width of mouth from angle to angle	79
Distance between two eyes	105
Length of first dorsal fin	59
Width of first dorsal fin	44
Length of second dorsal fin	37
Width of second dorsal fin	23
Length of pectoral fin	90
Width of pectoral fin	62
Length of pelvic fin	39
Width of pelvic fin	62
Length of anal fin	36
Width of anal fin	22

Reported by P. Nammalwar and S. Krishnapillai

It is reported that another specimen of *Rhincodon typus* has been caught in a purse seine operating in 15-18 m depth at about 2 km north of Karwar light house on 18th March 1983. The specimen measured 5.35 m from the tip of snout to the tip of upper caudal lobe, (Fig.2)

Reported, by M.H. Dhulkhed

Unique pollution detection method

A new "biosensor" designed for continuously monitoring water pollution has been developed by a researcher Mr Jean-Louis Huve of the Pierre and Marie Curie University at Paris. The basic layout of the new technique is a fish 'hooked' to a computer.

Fishes have a very highly developed sense of smell that enables them to detect extremely low concentrations (even a few isolated molecules in the case of amino acids) of natural or artificial substances in water. It is this characteristic which enables salmon to find out their migration routes. This has also been put to use since long in some drinking water pumping stations by studying the behaviour of trout in order to detect signs of pollution.

Mr Huve has made use of this idea in developing the electronic technique to monitor the pollution. In his instrument the electrical activity of the fish's olfactory bulb is recorded with two electrodes. A transmitter, working in a frequency band of 1 to 25 H picks up and transmits the current impulses (of about 50 microvolts) to a micro-computer. These are then decoded to show the electrical activity of the olfactory bulbs and a spectral analysis is made of the "electrobulbogramme" obtained. In this way it is possible to determine the polluting substance detected by the fish. The presence of pollutants can be easily recognised by the strong disturbance of the spectrum.

The instrument of the size of a small box, attached to the dorsal aspect of the head of the trout, is capable of indicating in half a second the presence of a gram of pesticide in 100,000 m³ of water - ten times below the concentrations prescribed by European safety regulations for drinking water. A French company 'MONDI-ALCOM' is planning to market the detector, which would not cost more than 60 to 75 thousand Rupees, according to an official of the company. Mr Huve is at present trying to develop his technique for application to marine pollution detection, using bass instead of trout. He believes that atmospheric pollution detection also would be possible by a similar type of equipment fixed on rats.

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